A VISUAL DISPLAY DEVICE AND A METHOD OF GENERATING A VISUAL DISPLAY SIGNAL THEREFOR

Field of the invention

The invention relates to a visual display device and a method of generating a visual display signal therefor and in particular to a visual display suitable for night time vision.

Background of the Invention

In the last decades, the use of portable electronic devices has increased significantly. Over the decades cost, power consumption and size has reduced significantly for electronic circuitry. In particular, micro processors have become so cheap, small and power efficient that they are now used in many devices that previously used more complex and expensive circuitry. This has allowed the functionality of many electronic devices to be significantly increased. For example, most portable two way radios now include microprocessors or microcontrollers allowing for complex functions. Consequently, there has been a significant increase in the use of complex electronic displays with portable devices thereby facilitating the operation of the complex devices and allowing for additional information to be displayed.

In addition, the developments have allowed for many new types of electronic devices to be developed. For example, small pocket sized general purpose computers have been developed. These devices are generally known as Personal Digital Assistants (PDAs), and typically comprise a microprocessor, associated memory and a touch sensitive display used for both input and

output. The display is typically under the control of the application running on the PDA.

However, for certain uses and users, special requirements or preferences exist. For example many security forces, police, fire services etc use a number of electronic devices with electronic displays including for example radios, vehicle computers, and general purpose devices (including devices similar to PDAs). However, for these services it is typically desirable that the electronic display may be easily read by the intended user but not by others. It is therefore a significant disadvantage that conventional electronic displays provide a high visibility over a large viewing angle and range.

Furthermore, many devices may be used during reduced light conditions such as for example during night time. In low light situations, the human vision typically adapts to the low light conditions thereby improving the ability to see in the current conditions. This is known as night vision and is important in many situations including many operations performed by for example the police or security forces. However, it is a significant disadvantage of conventional electronic displays that they have a detrimental effect on a user's night vision. Specifically, the display will cause a users vision to adapt to the increased luminance of the display thereby impairing the ability to see in low light conditions. This especially true for colour or greyscale devices as particularly white light has a detrimental effect on night vision.

Some displays have been developed seeking to remedy the problem. For example, some astronomy programmes for PDA's have a night vision mode, wherein a normal display is substituted by a display using a single dim red colour. However, this display mode not only results in loss of colour information but also in loss of all grey scale information thereby significantly reducing the quality, visibility and information content of the display.

It is also known to produce red filters that can be placed over electronic displays for PDAs. These filters have decreased attenuation for red wavelengths in comparison to other wavelengths thereby providing for a red tinted and typically attenuated light emission from the electronic display. However, these filters are impractical to use and require manual mounting and removal. Furthermore, they degrade or destroy the colour balance of the display thereby causing a significant degradation in the quality of the display.

Hence, an improved system for generating a visual display signal for an electronic display would be advantageous. In particular a system allowing for reduced impact on a user's low light vision and/or reducing visibility for unintended observers would be advantageous.

Summary of the Invention

Accordingly, the Invention seeks to mitigate, alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination. Specifically, the Inventor has realised that an improved system for generating a visual display signal for a low light and/or sensitive situations may be realised by generating a substantially monochromatic scale signal.

According to a first aspect of the invention there is provided a method of generating a visual display signal, the method comprising the steps of: receiving a colour signal comprising a plurality of colour signal components; weighting the colour signal components to generate weighted colour signal components; and generating a substantially monochromatic scale signal for a reduced emission visual display in response to the weighted colour signal components.

The term "monochromatic" refers to the scale signal having one colour or hue and does not relate to black and white display characteristics or properties.

As a monochromatic signal of a suitable colour may have a significantly beneficial effect on the user's ability to see in low light conditions, an improved display for use in low light conditions is enabled. Additionally, the visibility to other observers may be significantly reduced for a monochromatic signal.

The monochromatic scale signal may specifically retain the contrast and/or light intensity and/or light graduations of the colour signal. Hence, the monochromatic scale signal may be equivalent to the corresponding grey scale signal. For example, if a grey scale signal can be defined as having "n" different values from zero to full amplitude on a black and white display, then similarly a monochromatic scale signal can have "n" different values from zero to full amplitude on one colour input of a colour display. As contrast and/or light intensity information may be substantially retained, the loss of display information may be minimised to a loss of colour information.

The use of a monochromatic scale signal allows for reduced emission thereby impeding undesired viewing of the display. Furthermore, a monochromatic signal allows advantages when used in a reduced light environment as the detrimental effect on the ability of the human eye to see in low light intensity conditions is significantly reduced for a monochromatic display of the appropriate colour. In particular, the impact on a user's night vision may be significantly mitigated. Furthermore, the method is easy to implement by low complexity methods and may be easily embedded in the functionality of an electronic device.

Hence, the invention allows for an improved visual display signal for low light viewing conditions and/or viewing in sensitive conditions.

According to a feature of the invention, the step of generating the substantially monochromatic scale signal comprises summing the weighted colour signal components. This provides a simple and suitable means for generating the substantially monochromatic scale signal.

According to a feature of the invention, the monochromatic scale signal is a red monochromatic scale signal. A red monochromatic signal is particularly advantageous by having a particularly low impact on the human eye's ability to see in low light conditions. The red colour is preferable for preserving night vision sensitivity and allows for maximum dark adaptation. The red colour is also suitable for reducing the possibility of undesired observers noticing or viewing a display.

According to another feature of the invention, the step of generating comprises generating a substantially monochromatic signal component in response to the weighted colour signal components and eliminating other monochromatic signal components.

The visual display signal may for example be made up of a plurality of monochromatic signal components, based on primary colours such as Red, Green and Blue signal components, and the substantially monochromatic scale signal may simply be generated by setting all but one monochromatic signal component to zero. This allows for a low complexity method of generating a monochromatic scale signal while ensuring that the signal is a monochromatic signal.

According to another feature of the invention, the plurality of colour signal components is monochromatic colour signal components of a colour display signal.

A convenient way of producing and distributing a colour display signal is by combining a number of monochromatic colour signal components. Hence, the invention allows for a substantially monochromatic scale signal to be generated from weighted monochromatic colour signal components. The weighted monochromatic colour signal components may for example be summed.

According to another feature of the invention, the plurality of colour signal components comprises a red colour signal component, a green colour signal component and a blue colour signal component. A colour signal is conveniently made from a red, green and blue monochromatic signal component. Such a signal is known as an RGB signal. Hence, the substantially monochromatic scale signal is preferably generated from an RGB signal.

According to another feature of the invention, the step of generating comprises generating the substantially monochromatic scale signal by summation of the plurality of weighted colour signal components wherein the red colour signal component is weighted by a factor between 17% and 27%.

Preferably, the substantially monochromatic scale signal is generated as a summation of monochromatic signal components wherein the weights add up to a value, W, and the light intensity of the red monochromatic signal is multiplied by a factor between $0.17 \cdot W$ and $0.27 \cdot W$ before being added to the other monochromatic signal components. Preferably a maximum light intensity of the red monochromatic signal component will result in a contribution of the light intensity of the substantially monochromatic scale signal of between 17% and 27% of the maximum light intensity. This range is suitable for a light intensity perception of the human eye for a red component of a colour signal.

According to another feature of the invention, the step of generating comprises generating the substantially monochromatic scale signal by summation of the plurality of weighted colour signal components wherein the green colour signal component is weighted by a factor between 61% and 81%.

Preferably, the substantially monochromatic scale signal is generated as a summation of monochromatic signal components wherein the weights add up to a value, W, and the light intensity of the green monochromatic signal is multiplied by a factor between 0.61·W and 0.81·W before being added to the other monochromatic signal components. Preferably a maximum light intensity of the green monochromatic signal component will result in a contribution of the light intensity of the substantially monochromatic scale signal of between 61% and 81% of the maximum light intensity. This range is suitable for a light intensity perception of the human eye for a green component of a colour signal.

According to another feature of the invention, the step of generating comprises generating the substantially monochromatic scale signal by summation of the plurality of weighted colour signal components wherein the blue colour signal component is weighted by a factor between 2% and 12%.

Preferably, the substantially monochromatic scale signal is generated as a summation of monochromatic signal components wherein the weights add up to a value, W, and the light intensity of the blue monochromatic signal is multiplied by a factor between 0.02·W and 0.12·W before being added to the other monochromatic signal components. Preferably a maximum light intensity of the blue monochromatic signal component will result in a contribution of the light intensity of the substantially monochromatic scale signal of between 2% and 12% of the maximum light intensity. This range is suitable for a light intensity perception of the human eye for a blue component of a colour signal.

According to another feature of the invention, the step of generating comprises generating the substantially monochromatic scale signal as a summation of the red colour signal component weighted by a factor of substantially 0.22, the green colour signal component weighted by a factor of substantially 0.71 and the blue colour signal component weighted by a factor of substantially 0.07

Preferably, the substantially monochromatic scale signal is given as in the ITU standard YUV signal, namely the red colour signal component multiplied by 0.22 plus the green colour signal component multiplied by 0.71 plus the blue colour signal component multiplied by 0.07. This provides for a substantially monochromatic scale signal having a light intensity corresponding to the human eyes intensity perception of the corresponding RGB colour signal.

According to another feature of the invention, the step of weighting the colour signal components comprises setting an amplification characteristic for the plurality of colour signal components.

This provides for a suitable implementation of the method of generating the visual display signal.

According to another feature of the invention, the method further comprises the step of receiving a user input and wherein the visual display signal is generated as a visual colour signal or as the substantially monochromatic scale signal in response to the user input.

The user may preferably select between a colour signal and a monochromatic scale signal and specifically between the colour signal comprising the plurality of colour signal components and the corresponding monochromatic scale signal. Depending on the user's preference, a normal colour display or a monochromatic display suitable for low light and/or reduced visibility may

thus be selected, thereby enabling selection of the display type most suitable for the current operating conditions.

According to another feature of the invention, the method further comprises the step of determining an ambient light characteristic and wherein the visual display signal is generated as a visual colour signal or as the substantially monochromatic scale signal in response to the ambient light characteristic.

An automatic selection may preferably be performed between a visual colour signal and a monochromatic scale signal and specifically between the colour signal comprising the plurality of colour signal components and the corresponding monochromatic scale signal. Depending on the operating ambient light conditions, a normal colour display or a monochromatic display suitable for low light reduced visibility may thus be selected without requiring an action from the user.

According to another feature of the invention, the method further comprises the step of determining an ambient light dominant colour and wherein the visual display signal is generated as a substantially monochromatic scale signal being a complementary colour to the ambient light dominant colour.

An automatic selection may be made of the monochromatic scale colour such that it is the complementary colour to the dominant colour present in the ambient light conditions. The complementary colour may for example include up to 100% of two primary colours.

According to another feature of the invention, the step of receiving the colour signal comprises intercepting the plurality of colour signal components between a signal source and a signal display.

This enables a suitable method for providing a monochromatic scale signal in a display system based on a colour signal comprising a plurality of colour signal components. It further allows for the added benefits of easy introduction of a monochromatic scale signal in an existing system.

According to another feature of the invention, the step of receiving the colour signal comprises intercepting the plurality of colour signal components in association with a video memory operation. This provides for a suitable method of receiving the colour signal.

According to a second aspect of the invention, there is provided a visual display device comprising: means for receiving a colour signal comprising a plurality of colour signal components; means for weighting the colour signal components to generate weighted colour signal components; means for generating a substantially monochromatic scale signal for a reduced emission visual display in response to the weighted colour signal components; and display means for displaying the substantially monochromatic scale signal.

These and other aspects and advantages of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

Brief Description of the Drawings

An embodiment of the invention will be described, by way of example only, with reference to the drawings, in which

FIG. 1 illustrates a visual display device in accordance with an embodiment of the invention;

FIG. 2 is an illustration of a method of generating a substantially monochromatic visual display signal in accordance with an embodiment of the invention; and

FIG. 3 illustrates an apparatus for generating a substantially monochromatic scale signal in accordance with an embodiment of the invention.

Detailed Description of a Preferred Embodiment of the Invention

The following description focuses on an embodiment of the invention applicable to a portable electronic device such as a portable radio, vehicle computer or Personal Digital Assistant (PDA). However, it will be appreciated that the invention is not limited to these applications but may be applied to many other visual display systems.

FIG. 1 illustrates a visual display device 100 in accordance with an embodiment of the invention. The visual display device may for example be a portable radio, a mobile phone or a vehicle computer. For clarity and brevity, the following description will focus on a specific embodiment wherein the visual display device 100 is a vehicle computer.

The visual display device 100 comprises a processing unit 101 which in the preferred embodiment consists of a central processor core module (cpu) having suitable processing, memory and input/ output functionality. The processing unit 101 is coupled to an external user input device 103, which is operable to receive user inputs. The processing unit 101 is further coupled to a display 105 which provides an interface to the user. For some applications, a touch sensitive display may be used and the user input device 103 and the display 105 may physically be the same physical unit. The processing unit is further coupled to an external memory 107. The external memory 107 comprises both

permanent memory, such as Read Only Memory (ROM), semi-permanent memory, such as FLASH memory, and dynamic memory, such as Random Access Memory (RAM). Furthermore, the memory 107 comprises both system memory, application memory and display memory.

In the following, functional modules of the processing unit 101 associated with displaying information on the display 105 will be described in more detail. It will be appreciated that the visual display device 100 typically comprises many other functional elements including application memory interfaces, operating system processing elements and possibly communication elements. The functional modules of the processing unit 101 may for example correspond to software routines or sections or hardware interfaces. However, it will be appreciated that the separation into different functional modules is only for the purpose of clarity and brevity of the description, and that the functionality of the visual display device 100 may be implemented and distributed in any suitable way, and may be performed at any suitable physical, structural or logical location.

The processing unit 101 comprises an application processor 109 which is operable to run applications of the visual display device 100. Specifically, for a PDA, the application processor 109 is operable to execute a number of different application programmes including for example word processing applications, diary applications and contact information management applications. For other visual display devices 100, such as a portable radio or vehicle computer, the application processor 109 may specifically be operable to execute control, information and management applications for another functional element. For example, a police vehicle computer may comprise a touch sensitive display for providing information to the user and receiving inputs from the user. In this case, the application processor may operate a control application for the display, an interface application for the user input, and a management application for controlling the radio part in response to the user input.

In the visual display device 100, the application processor 109 is coupled to a user input interface 111 that provides the appropriate interface to the user input device 103. This allows the application processor 109 to receive user inputs and to amend the operation accordingly.

Furthermore, the application processor 109 is coupled to a display driver 113 which is operable to receive display data from the application processor 109 and to generate an appropriate colour signal that can be presented on the display 105. In the preferred embodiment, the colour signal is in the form of colour values for individual pixels of the display.

In the described embodiment, the display driver 113 is coupled to a memory interface 115, which is further coupled to the memory 107. In the preferred embodiment, the memory 107 comprises a display memory. The display memory has a data location for each pixel of the display 105, and the display driver 113 is operable to change the display output by overwriting the data values of the memory locations corresponding to pixels that are to be modified. In the preferred embodiment, the memory display comprises a red colour value, a green colour value and a blue colour value for each pixel. Hence, the colour and intensity of each pixel is represented by three colour data values. Accordingly, in the preferred embodiment, the colour signal generated by the display driver 113 comprises three update colour data values for memory locations of pixels that are to be modified. Specifically, the display driver may simply address the appropriate memory locations and write the new data to these locations.

The memory interface 115 is further coupled to a display output interface 117. The display output interface 117 is operable to read the data values from the display memory through the memory interface 115. In the preferred embodiment, the memory locations are read corresponding to a sequential

reading of pixel values. Hence, a digital colour signal is generated by a cyclical and sequential reading of the data values of the display memory. The data values stored in the display memory may in themselves be considered a colour signal. Specifically, the display output interface reads the red, green and blue data values for the first pixel of the display. It then generates an appropriate signal for the light emitting element(s) of the first pixel to emit a light having the appropriate colour and intensity. Consequently, the display output interface proceeds to the next pixel, reads the appropriate data values and generates an appropriate colour signal for that pixel. The display output interface 117 continually repeats this process for all pixels of the display 105.

In the preferred embodiment, the processing unit 101 further comprises a display processor 119 coupled to the memory interface 115 and the display output interface 117. The display processor 119 is in the preferred embodiment operable to intercept the colour signal between the memory interface 115 and the display output interface 117 and to generate a substantially monochromatic scale signal from the colour signal. The substantially monochromatic scale signal may be fed to the display output interface, and the display output may be based on either the received colour signal or the substantially monochromatic scale signal.

Hence, in the preferred embodiment, the display output interface 117 is fed both a colour signal and a corresponding monochromatic scale signal. Accordingly, the display output interface 117 may generate a colour display or a substantially monochromatic display. The selection between these display types is in the preferred embodiment controlled by the application processor 109 in response to a user input. In this way, the user can directly switch the display between a colour display and a monochromatic display.

In another embodiment, the display processor 119 is connected between the memory interface 115 and the display output interface 117. In this

embodiment, all data values from the display memory pass through the display processor 119, which may convert these values into a substantially monochromatic scale signal. In this embodiment, the display processor 119 is preferably operable to pass the data unchanged thereby allowing for either a colour signal or a monochromatic signal to be displayed. In yet another embodiment, the display processor 119 is operable to directly operate on the colour signal stored in the display memory. It may thus directly access the memory locations of the display memory and modify stored data values such as to modify the stored colour signal to be a substantially monochromatic scale signal.

In another embodiment, the display processor 119 may be coupled between the display driver 113 and the memory interface 115. In this embodiment, the stored display signal of the display memory is thus a substantially monochromatic scale signal.

FIG. 2 is an illustration of a method of generating a substantially monochromatic visual display signal in accordance with an embodiment of the invention. The method is in the following described with specific reference to the visual display device 100 of FIG.1. In the preferred embodiment, the method is executed by the display processor 119.

In step 201, a colour signal is received. The colour signal comprises a plurality of colour signal components. In the preferred embodiment, the colour signal comprises substantially monochromatic colour signal components, and the colour of the display signal is given from the relative strength of each monochromatic signal component as is known in the art. In the preferred embodiment, the colour signal is made up by a red chromatic signal component; a green chromatic signal component and a blue chromatic signal component. The colour signal thus preferably corresponds to an RGB signal as known in the art.

The colour signal may further be any suitable representation of a colour signal including for example analogue composite video signals, RGB signals, discrete digital data values, stored representations of pixel values or any other information that may be translated into a colour display. In the specific example, the colour signal consists in the red, green and blue digital data values read from the display memory by the display output interface.

In step 203, which follows step 201, the colour signal components are weighted whereby weighted colour signal components are generated. Step 203 is followed by step 205, wherein a substantially monochromatic scale signal is generated in response to the weighted colour signal components. The generated substantially monochromatic scale signal has a reduced emission to the human eye in comparison to the original colour signal for the same brightness. The substantially monochromatic scale signal provides for a display having less impact on a user's ability to see in low light conditions. It also provides for reduced visibility to unintended observers. It thus provides an improved signal for use in low light and/or sensitive situations.

It is within the contemplation of the invention that any suitable algorithm for generating the substantially monochromatic scale signal from the colour signal components may be used. However, the weighting of the colour signal components is preferably such that the equivalent grey scale of the colour signal is substantially maintained according to one of the known optical relationships such as the ITU YUV standard. In addition, the colour balance of the signal is preferably maintained. The substantially monochromatic scale signal is in the preferred embodiment generated as a simple summation of the weighted colour signal components.

Specifically, in the preferred embodiment, the substantially monochromatic scale signal is generated using the ITU standard YUV relationship, namely as

a summation of the red colour signal component weighted by a factor of 0.22, the green colour signal component weighted by a factor of 0.71 and the blue colour signal component weighted by a factor of 0.07. The substantially monochromatic scale signal, Y, may thus specifically be generated as:

$$Y = (0.22 \cdot R + 0.71 \cdot G + 0.07 \cdot B) \cdot A$$

where R, G and B are the red, green and blue colour signal components respectively, and A is a suitable amplification factor which in the preferred embodiment has a unity value.

A substantially monochromatic scale signal generated in accordance with the above equation will have a luminance equivalent to a corresponding grey scale signal and will therefore effectively retain the grey scale information comprised in the colour signal as perceived by the user. It is within the contemplation of the invention that other algorithms and specifically other weighting coefficients may be used. However, preferably the relative weighting factor of the red colour signal component is between 0.12 and 0.32. Similarly, the relative weighting factor of the green colour signal component is preferably between 0.61 and 0.81 and the weighting factor of the blue colour signal component is preferably between 0.02 and 0.12. These values will provide for a substantially monochromatic scale signal having a reasonable grey scale equivalence.

Preferably, the substantially monochromatic scale signal is generated by setting a monochromatic signal component as described above, and setting the remaining signal components to zero. In the preferred embodiment, the substantially monochromatic scale signal is a red substantially monochromatic scale signal.

In this embodiment the red signal component of an RGB signal is set to a value as described above whereas both the green and blue signal component values are set to zero. In the preferred embodiment, this is achieved by simple mathematical operations on the digital values read from the display memory. In other embodiments, the data values may for example be directly modified in the display memory and/or already modified data may be stored in the display memory. A red monochromatic scale signal provides the maximum dark adaptation and is therefore optimum both for minimising the impact on a user's night vision and for reducing visibility to unintended observers. Also for particular ambient lighting conditions, such as may be present with more monochromatic road or street lighting such as sodium or mercury discharge lamps, a different monochromatic colour may be chosen. Further, in such an ambient light condition, we may generate a monochromatic colour which is the complementary colour to the ambient light so as to achieve the lowest visibility. The complementary colour may use up to 100% of two primary colours.

Step 205 is followed by step 207, wherein the generated substantially monochromatic scale signal is displayed on the display 105.

In the preferred embodiment, the visual display device 100 comprises means for selecting between a visual display signal corresponding to the original colour signal and the substantially monochromatic scale signal. This provides for a visual display device having functionality for providing both a normal colour signal and a reduced emission substantially monochromatic display as is suitable for the operating conditions and/or the user's preferences. In the preferred embodiment, the user may manually switch between a monochromatic display and a normal colour display. The user may provide the user input through the user input device, and the application processor may control the functionality of the display processor 119 and/or the display output interface 117 to select the desired visual display signal.

In another embodiment, the visual display device 100 comprises an ambient light detector which is operable to determine an ambient light characteristic. Preferably, the ambient light detector is a simple light intensity sensor, and the ambient light characteristic is simply an intensity of the ambient light. In the embodiment, the visual display device 100 is operable to automatically select between a visual display signal corresponding to the original colour signal and the substantially monochromatic scale signal in response to the ambient light characteristic. Specifically, the visual display device 100 selects the colour visual display signal for normal light conditions and the substantially monochromatic scale signal for low light conditions. In this way, the user is automatically presented with a display suited for the current ambient light conditions.

In another embodiment the dominant colour of the ambient lighting is detected and the substantially monochromatic signal is generated as the complementary colour to that dominant ambient colour.

FIG. 3 illustrates an apparatus 300 for generating a substantially monochromatic scale signal in accordance with an embodiment of the invention. The apparatus is particularly suitable for converting an analogue RGB colour signal into an analogue substantially monochromatic RGB signal. The apparatus comprises an input for the Red colour signal component 301, an input for the Green colour signal component 303 and an input for the Blue colour signal component 305.

The apparatus 300 further comprises an operational amplifier 307 coupled as an inverting summation amplifier as is well known in the art. Each of the colour signal component inputs 301, 303, 305 is coupled to the operational amplifier through a respective resistor R1, R2 and R3. A resistor R4 is coupled from the output to the inverting input of the operational amplifier 307. The

non-inverting input of the operational amplifier 307 is coupled to ground. The output signal of the operational amplifier 307 is given as:

$$V_{OI} = -\left(\frac{R_4}{R_1}\cdot V_R + \frac{R_4}{R_2}\cdot V_G + \frac{R_4}{R_3}\cdot V_B\right)$$

wherein V_R, V_G and V_B are the input voltages on the Red, Green and Blue colour signal component input 301, 303, 305 respectively.

The output of the operational amplifier 307 is connected to a second operational amplifier 309 coupled as an inverting buffer amplifier. A resistor R5 is connected between the output of the first operational amplifier 307 and the inverting input of the second operational amplifier 309, and a resistor R6 is coupled from the output to the inverting input of the second operational amplifier 309. The non-inverting input of the second operational amplifier is coupled to ground. The output voltage of the second operational amplifier is given by:

$$V_O = -\frac{R_6}{R_5}\cdot V_{OI}$$

In the preferred embodiment, the second operational amplifier is coupled as a unity gain buffer with R5=R6. This yields:

$$V_O = \frac{R_4}{R_1}\cdot V_R + \frac{R_4}{R_2}\cdot V_G + \frac{R_4}{R_3}\cdot V_B$$

In the preferred embodiment, the resistor values are chosen such that

$$V_O = 0.22 \cdot V_R + 0.71 \cdot V_G + 0.07 \cdot V_B$$

An additional resistor of value equal to the effective parallel combination of R1, R2, R3, R4, can be added in series with the non-inverting input of operational amplifier 307 so as to cancel input bias current effects.

The apparatus 300 further comprises three outputs 311, 313, 315, one for each of the Red, Green and Blue colour signal components respectively. The output of the second operational amplifier 309 is coupled to the Red colour signal component output 311, whereas the other colour signal component outputs 313, 315 are coupled to ground.

Hence, by use of simple inexpensive and standard components, an RGB colour signal may be converted into a substantially red monochromatic scale signal, which can be distributed as an RGB signal. The apparatus may thus be inserted in the path of an RGB signal thereby converting the colour RGB signal to an RGB signal being substantially monochromatic. The monochromatic scale signal has a perceived light intensity corresponding to the grey scale of the original RGB signal thereby retaining the grey scale information. More accurate weighting of the individual colour signal components may be achieved by use of more accurate resistor values or by adjustment.

The invention can be implemented in any suitable form including hardware, software, firmware or any combination of these. However, preferably, the invention is implemented as software running on one or more data processors and/or digital signal processors. The elements and components of an embodiment of the invention may be physically, functionally and logically implemented in any suitable way. Indeed the functionality may be implemented in a single unit, in a plurality of units or as part of other

functional units. As such, the invention may be implemented in a single unit or may be physically and functionally distributed between different units and processors.

Although the present invention has been described in connection with the preferred embodiment, it is not intended to be limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the accompanying claims. In the claims, the term comprising does not exclude the presence of other elements or steps. Furthermore, although individually listed, a plurality of means, elements or method steps may be implemented by e.g. a single unit or processor. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. In addition, singular references do not exclude a plurality. Thus references to "a", "an", "first", "second" etc do not preclude a plurality.

CLAIMS

1. A method of generating a visual display signal, the method comprising the steps of:

receiving (201) a colour signal comprising a plurality of colour signal components;

weighting (203) the colour signal components to generate weighted colour signal components; and

generating (205) a substantially monochromatic scale signal for a reduced emission visual display in response to the weighted colour signal components.

2. A method as claimed in claim 1 wherein the step of generating (205) the substantially monochromatic scale signal comprises summing the weighted colour signal components.

3. A method as claimed in claim 1 or 2 wherein the monochromatic scale signal is a red monochromatic scale signal.

4. A method as claimed in any previous claim wherein the step of generating (205) comprises generating a substantially monochromatic signal component in response to the weighted colour signal components and eliminating other monochromatic signal components.

5. A method as claimed in any previous claim wherein the plurality of colour signal components is monochromatic colour signal components of a colour display signal.

6. A method as claimed in any previous claim wherein the plurality of colour signal components comprises a red colour signal component, a green colour signal component and a blue colour signal component.

7. A method as claimed in claim 6 wherein the step of generating (205) comprises generating the substantially monochromatic scale signal by summation of the plurality of weighted colour signal components wherein the red colour signal component is weighted by a factor between 17% and 27%.

8. A method as claimed in claim 6 wherein the step of generating (205) comprises generating the substantially monochromatic scale signal by summation of the plurality of weighted colour signal components wherein the green colour signal component is weighted by a factor between 61% and 81%.

9. A method as claimed in claim 6 wherein the step of generating (205) comprises generating the substantially monochromatic scale signal by summation of the plurality of weighted colour signal components wherein the blue colour signal component is weighted by a factor between 2% and 12%.

10. A method as claimed in claim 6 wherein the step of generating (205) comprises generating the substantially monochromatic scale signal as a summation of the red colour signal component weighted by a factor of substantially 0.22, the green colour signal component weighted by a factor of substantially 0.71 and the blue colour signal component weighted by a factor of substantially 0.07

11. A method as claimed in any previous claim wherein the step of weighting (203) the colour signal components comprises setting an amplification characteristic for the plurality of colour signal components.

12. A method as claimed in any previous claim further comprising the step of receiving a user input and wherein the visual display signal is generated as a visual colour signal or as the substantially monochromatic scale signal in response to the user input.

13. A method as claimed in any previous claim further comprising the step of determining an ambient light characteristic and wherein the visual display signal is generated as a visual colour signal or as the substantially monochromatic scale signal in response to the ambient light characteristic.

14. A method as claimed in any previous claim further comprising the step of determining an ambient light dominant colour and wherein the visual display signal is generated as a substantially monochromatic scale signal being a complimentary colour to the ambient light dominant colour.

15. A method as claimed in any previous claim wherein the step of receiving (201) the colour signal comprises intercepting the plurality of colour signal components between a signal source and a signal display.

16. A method as claimed in any previous claim wherein the step of receiving (201) the colour signal comprises intercepting the plurality of colour signal components in association with a video memory operation.

17. A computer program enabling the carrying out of a method according to any of the precious claims.

18. A record carrier comprising a computer program as claimed in claim 17.

19. A visual display device comprising:

means for receiving a colour signal comprising a plurality of colour signal components;

means for weighting the colour signal components to generate weighted colour signal components;

means for generating a substantially monochromatic scale signal for a reduced emission visual display in response to the weighted colour signal components; and

display means for displaying the substantially monochromatic scale signal.

ABSTRACT

A VISUAL DISPLAY DEVICE AND A METHOD OF GENERATING A VISUAL DISPLAY SIGNAL THEREFOR

The invention relates to a system for generating a visual display signal comprising a substantially monochromatic scale signal. A visual display device (100) comprises a display processor (119) which comprises means for receiving a colour signal. The colour signal comprises a plurality of colour signal components, and specifically the signal may be an RGB signal. The display processor (119) further comprises means for weighting the colour signal components to generate weighted colour signal components, and means for generating a substantially monochromatic scale signal for reduced emission visual display in response to the weighted colour signal components. The scale signal may specifically be generated as $0.22 \cdot R + 0.71 \cdot G + 0.07 \cdot B$. The scale signal is displayed on a display (105). The monochromatic scale signal is preferably a red monochromatic scale signal suitable for night time use and providing low visibility for unintended observers.

FIG. 1 to accompany the abstract.

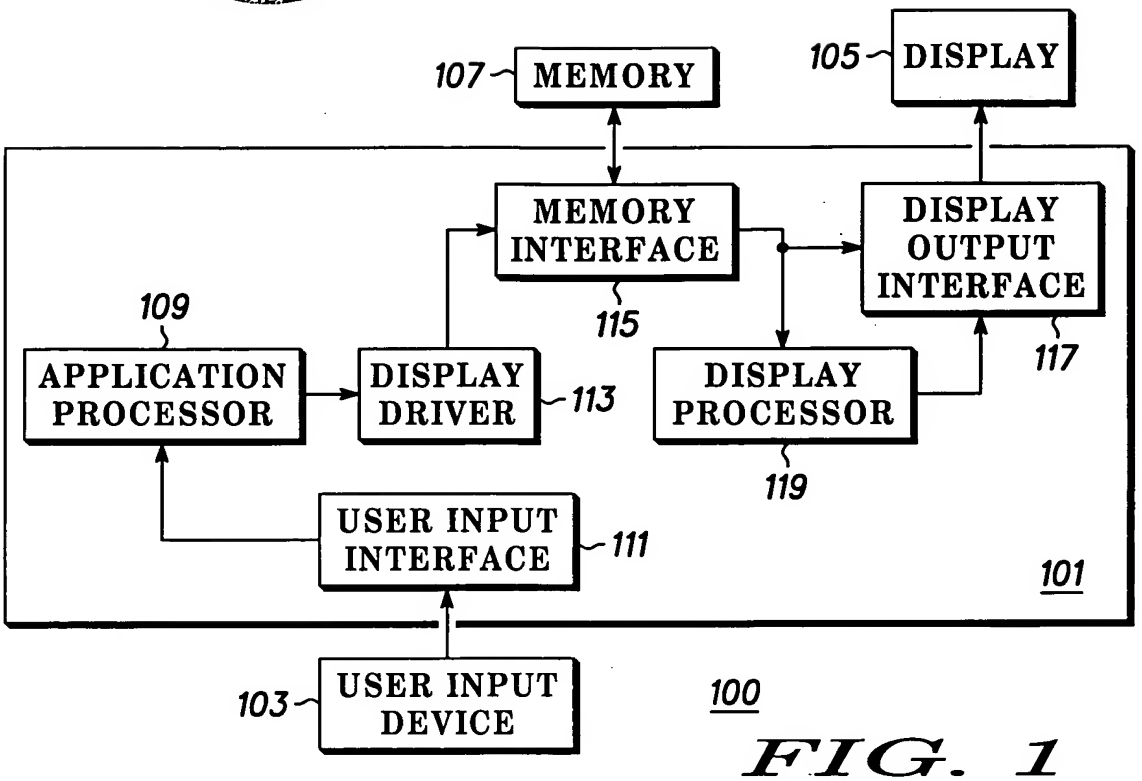

FIG. 1

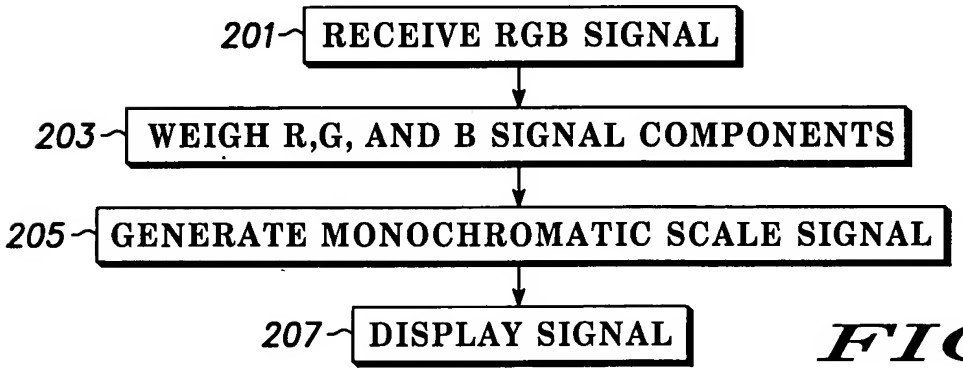

FIG. 2

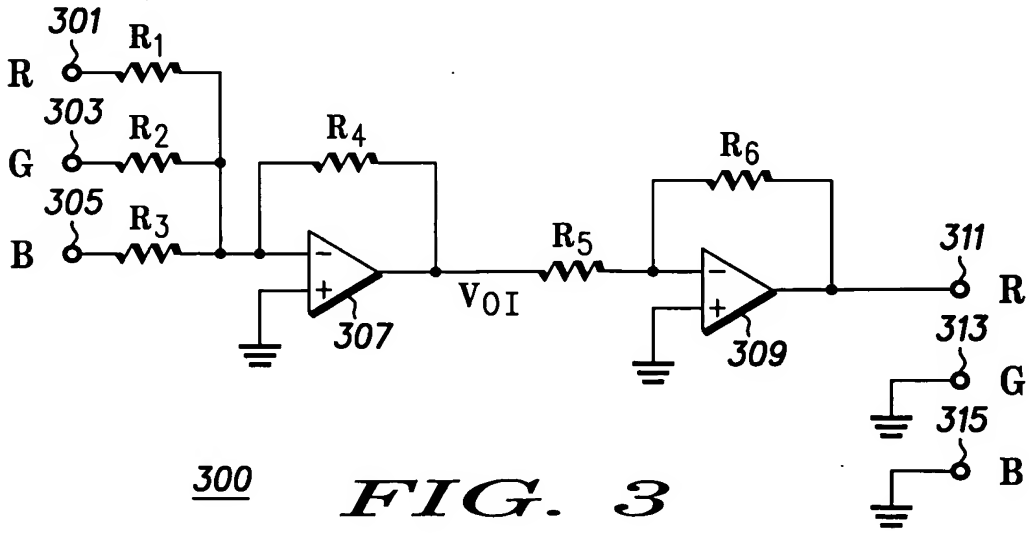

FIG. 3